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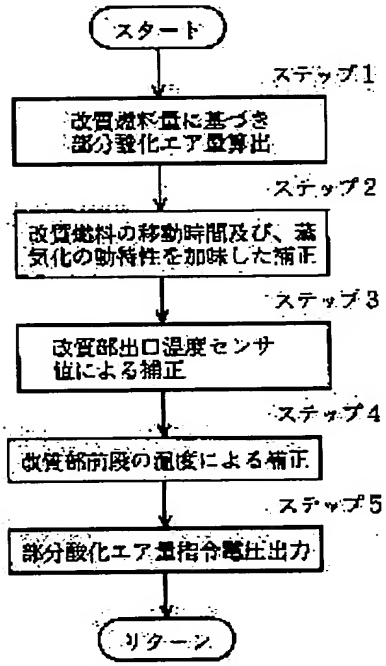
(71)Applicant : TOYOTA MOTOR CORP
(72)Inventor : EIMIYA KIYOMI
YAMASHITA KATSUJI
YAMAOKA MASAAKI
MOTOZONO KIICHI

(54) CONTROLLER OF REFORMER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a controller capable of maintaining a reforming reaction temp. at which a partial oxidation reforming reaction is adequately effected nearly constantly at a target temp.
SOLUTION: This controller for a reformer reforms reforming fuel to fuel of a prescribed form by the reforming reaction accompanied by heat absorption and the partial oxidation reforming reaction accompanied by heat generation. The controller has an oxygen quantity determining means (step 1) for determining the quantity of the oxygen to be supplied for the purpose of the partial oxidation reforming reaction in accordance with the reforming fuel quantity for reforming the fuel to the fuel of the prescribed form, the theoretical heat absorption quantity in the reforming reaction accompanied by the heat absorption and the theoretical heat generation quantity in the partial oxidation reforming reaction.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] In the control unit of the reforming machine which reforms a reforming fuel to the fuel of a predetermined gestalt by the reforming reaction accompanied by endoergic, and the partial oxidation reforming reaction accompanied by generation of heat The amount of the oxygen supplied for said partial oxidation reforming reaction The control unit of the reforming machine characterized by having an amount decision means of oxygen to determine based on the reforming fuel quantity which should be reformed to the fuel of said predetermined gestalt, the amount of theoretical endoergic in the reforming reaction accompanied by endoergic [said], and the theoretical calorific value in said partial oxidation reforming reaction.
[Claim 2] The control unit of the reforming machine according to claim 1 characterized by having further a delay amendment means to amend the amount of oxygen determined with said amount decision means of oxygen based on the time lag from supply of said reforming fuel to a reforming reaction.
[Claim 3] The control unit of the reforming machine of claim 1 characterized by having further a temperature detection means to detect the temperature of the part which the reforming reaction of a reforming fuel produces, and a temperature compensation means to amend the amount of oxygen determined with said amount decision means of oxygen based on the detected temperature.
[Claim 4] The control unit of the reforming machine of claim 1 characterized by to have further a command value setting means set up the command value which supplies the oxygen for a partial-oxidation reforming reaction, based on the amount of oxygen determined with a presumed means presume the supply quantity of state of the oxygen for said partial-oxidation reforming reaction to the part which the reforming reaction of said reforming fuel produces, and the oxygen-supply quantity of state presumed with this presumed means and said amount decision means of oxygen.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention -- reforming fuels, such as hydrocarbons, such as methyl alcohol, and water, -- hydrogen -- it is related with the equipment for controlling the partial oxidation reforming reaction in the reforming machine which uses together especially a partial oxidation reforming reaction about the reforming machine reformed to fuels of a desired gestalt, such as rich reformed gas.
[0002]
[Description of the Prior Art] The thing of a configuration of generating the reformed gas which reforms the mixed steam of a methanol and water and makes hydrogen a subject as this kind of a reforming machine is known. The reforming reaction in the reforming machine is a steam-reforming reaction which mainly produces hydrogen gas by the reaction of the methanol and steam which are expressed with the following formula.
CH3 OH+H2O->3H2+CO 2 (+CO)-49.5 (kJ/mol) -- (1)
Therefore, since it is an elevated temperature comparatively, in order [whose steam-reforming reaction of this is endothermic reaction and / whose activity temperature of a reforming catalyst is about 300 degrees C] to make a reforming reaction continue, it is necessary to supply that heat of reaction.
[0003] On the other hand, there is a partial oxidation reforming reaction which produces hydrogen by oxidation reaction as a reforming reaction of a methanol. This is exothermic reaction as expressed with the following formula.
CH3OH+1/2O2 ->2H2+CO 2+189.6 (kJ/mol) -- (2)
[0004] Since these steam-reforming reactions and a partial oxidation reforming reaction can be produced in parallel, endoergic [in a steam-reforming reaction] is suppliable with generation of heat of a partial oxidation reforming reaction. The so-called partial oxidation concomitant use type of such a fuel cell system is indicated by JP,7-57756,A. In invention indicated by this official report, after heating the air pressurized by the compressor by the heat exchanger, it introduces into a reforming machine and it is supposed that a partial oxidation reaction will be produced. However, about the amount of the air to introduce, it has not considered as the object of control especially. This is considered to be because for there to be [therefore] almost no fluctuation of a load for the so-called system of a non-portable type with the large-sized system indicated by the aforementioned official report.
[0005]
[Problem(s) to be Solved by the Invention] The amount of endoergic in a steam-reforming reaction differs from the calorific value in a partial oxidation reforming reaction greatly so that it may be known from the reaction formula shown above. Therefore, if each of these reactions arise about an one-mol methanol in coincidence, calorific value may increase, whenever [catalyst temperature] may become an elevated temperature superfluously, and the activity and endurance may fall. Moreover, if the partial oxidation reforming reaction is dull on the contrary, there is un-arranging [more than which the temperature of a reforming catalyst falls and the amount of residual methanols and the amount of generation of carbon monoxide gas increase].
[0006] Thus, though a partial oxidation reforming reaction is produced, abnormalities will be caused to a reforming reaction depending on extent of the reaction. Therefore, although it is necessary to control the partial oxidation reaction by the reforming machine of a partial oxidation concomitant use mold proper, in the conventional system indicated by the official report mentioned above, the concrete controlled system or the control approach for controlling a partial oxidation reaction are not recognized at all. Therefore, it was difficult for the temperature of which the temperature of the reforming section is required by the reforming

reaction with the conventional equipment mentioned above to maintain stably, and when changing the amount of a reforming fuel with fluctuation of the load in the energy conversion machine which consumes reforming fuels, such as a fuel cell, especially, temperature of the reforming section, such as temperature of a reforming catalyst, became unstable, consequently there was possibility of the quality of reformed gas deteriorating.

[0007] This invention makes the above-mentioned situation a background, and is made, and it aims at offering a stably maintainable control unit to the temperature of which the temperature of the reforming machine which uses a partial oxidation reforming reaction together is required by the reforming reaction.

[0008]

[Means for Solving the Problem and its Function] It notes that a partial oxidation reaction arises according to the amount of oxygen introduced into the reforming section in order that this invention may attain the above-mentioned purpose. The inside of the amount required of the reforming fuel with which an endoergic reforming reaction and a partial oxidation reforming reaction are presented in the amount of oxygen, It is characterized by constituting so that it may determine based on the reforming fuel quantity with which the partial oxidation reforming reaction for which it opted based on the ratio of the amount of theoretical endoergic in an endoergic reforming reaction and the theoretical calorific value in a partial oxidation reforming reaction is presented. In the control unit of the reforming machine to which invention of claim 1 more specifically reforms a reforming fuel to the fuel of a predetermined gestalt by the reforming reaction accompanied by endoergic, and the partial oxidation reforming reaction accompanied by generation of heat The amount of the oxygen supplied for said partial oxidation reforming reaction It is characterized by having an amount decision means of oxygen to determine based on the reforming fuel quantity which should be reformed to the fuel of said predetermined gestalt, the amount of theoretical endoergic in the reforming reaction accompanied by endoergic [said], and the theoretical calorific value in said partial oxidation reforming reaction.

[0009] moreover, invention of claim 2 -- the configuration of claim 1 -- in addition, it is characterized by having further a delay amendment means to amend the amount of oxygen determined with said amount decision means of oxygen based on the time lag from supply of said reforming fuel to a reforming reaction.

[0010] invention of claim 3 -- the configuration of claim 1 -- in addition, it is characterized by having further a temperature detection means to detect the temperature of the part which the reforming reaction of a reforming fuel produces, and a temperature compensation means to amend the amount of oxygen determined with said amount decision means of oxygen based on the detected temperature.

[0011] Invention of claim 4 in the configuration of claim 1 And in addition, a presumed means to presume the supply quantity of state of the oxygen for said partial oxidation reforming reaction to the part which the reforming reaction of said reforming fuel produces, It is characterized by having further a command value setting means to set up the command value which supplies the oxygen for a partial oxidation reforming reaction, based on the amount of oxygen determined with the oxygen supply quantity of state presumed with this presumed means, and said amount decision means of oxygen.

[0012] Therefore, since the amount of the oxygen with which the business of a partial oxidation reforming reaction is presented is determined based on the amount, and the amount of theoretical endoergic and theoretical calorific value accompanying a reforming reaction of the reforming fuel which should be carried out reforming according to invention of claim 1 The temperature of the part which the amount of endoergic and calorific value accompanying a reforming reaction are made to balance, and a reforming reaction produces can be maintained to predetermined temperature, consequently a reforming reaction is advanced good, the fuel of high quality is obtained and the thing of it can be carried out.

[0013] Moreover, since according to invention of claim 2 the amount of supply oxygen is amended according to the time delay of fluctuation of the reforming reaction accompanying fluctuation of the amount when the amount of a reforming fuel has fluctuation, the temperature of the part which a reforming reaction produces is maintained still more correctly, and the fuel of the high quality which changed the gestalt can be obtained.

[0014] Since the oxygen supply with which oxidation reaction is presented is amended based on the temperature of the part which a reforming reaction produces according to invention of claim 3, the temperature of the part which a reforming reaction produces is controlled still more correctly, consequently a reforming reaction is stabilized, and the fuel of the high quality which changed the gestalt can be obtained.

[0015] And since in outputting the command signal for supplying the oxygen of the amount determined with the amount decision means of oxygen according to invention of claim 4 quantity of states, such as a supply

pressure of oxygen, are presumed and an oxygen supply command value is set up based on the estimate, the amount of supply of oxygen becomes exact, consequently a reforming reaction is stabilized, and the fuel of the high quality which changed the gestalt can be obtained.

[0016]

[Embodiment of the Invention] This invention is explained based on the example shown in drawing below. First, the system which used the fuel cell as an energy conversion machine which changes into the energy of other gestalten the reformed gas which used the reforming machine which used a methanol and water as the reforming fuel as a reforming machine, and was produced from the reforming machine is explained.

Drawing 2 shows the example typically and the reforming machine 2 is connected to the fuel electrode side of a fuel cell 1. This reforming machine 2 reforms the mixture of the methanol and water which are a reforming fuel to the reformed gas which uses hydrogen and a carbon dioxide as a principal component, and is equipped with the heating unit 3 which heats a reforming fuel, the reforming section 4, and CO oxidation section 5.

[0017] The heating unit 3 is constituted by the evaporator 7 which evaporates a reforming fuel with the combustion section 6 which it is [section] and generates the heat for heating and its heat for heating a reforming fuel and producing the mixed steam of a methanol and water. The thing of a configuration of oxidizing the thing and heating fuel of the structure of burning a heating fuel with a burner, according to a catalyst as the combustion section 6 etc. is employable. Therefore, the Ayr feed zone 10 which the pump 8 which supplies the methanol which is an example of a heating fuel is connected through an injector 9, and supplies the air which is an example of susceptibility-of-substances-to-burn gas is formed in this combustion section 6. Specifically, this Ayr feed zone 10 is constituted by the air pump.

[0018] Moreover, the pump 11 is connected to the evaporator 7 as a reforming fuel feed zone which supplies the mixed liquor of a methanol and water. And it is connected by this evaporator 7 and said combustion section 6 possible [heat transfer by the heat exchanger 12].

[0019] Said reforming section 4 is constituted so that the reformed gas which uses hydrogen as a principal component mainly by the reforming reaction of a methanol may be generated. The reforming reaction is with the so-called steam-reforming reaction shown by the above-mentioned (1) formula, and the so-called partial oxidation reforming reaction shown by (2) formulas, since these reactions are produced, as shown in drawing 3 , activity temperature is established for the catalyst bed 41 which consists of a catalyst of the copper system which is about 280-300 degrees C in the chamber 42, and said evaporator 7 is connected to the feed hopper 43 of the chamber 42. Moreover, the partial oxidation Ayr supply pipe 44 which supplies oxygen for a partial oxidation reaction is connected to the feed hopper 43. And the air pump 13 is connected to this partial oxidation Ayr supply pipe 44.

[0020] Moreover, the temperature sensors 46 and 47 which detect the temperature of a catalyst bed 41 and output a signal to a feed hopper [of a chamber 42] 43 and exhaust port 45 side are arranged, respectively. Furthermore, the pressure sensor 48 is arranged at the exhaust port 45 side.

[0021] The reforming reaction shown by the above-mentioned (1) type and (2) formulas is a reaction of an ideal condition, and since a carbon dioxide changes to a carbon monoxide reversibly, carbon monoxide gas mixes in reformed gas unescapable in fact. Since this carbon monoxide becomes the cause which carries out poisoning of the catalyst of the fuel electrode in a fuel cell 1, in order to remove this, CO oxidation section 5 is formed. This CO oxidation section 5 is equipped with the Ayr feed zone 14, and it is constituted by passing the reformed gas made to generate in the reforming section 4 so that the carbon monoxide contained in reformed gas may be oxidized by the oxygen in air, while having CO oxidation catalyst (not shown).

[0022] On the other hand, a fuel cell 1 uses a poly membrane with proton permeability as an electrolyte as an example, forms a fuel electrode (hydrogen pole) 15 and an air pole (oxygen pole) 16 on both sides of the electrolyte membrane, connects many cells of such a configuration to a serial parallel, and is constituted. Each electrodes 15 and 16 are constituted by a diffusion layer and the reaction layer, and let the reaction layer in a fuel electrode 15 be the vesicular structure which made carbon support catalysts, such as platinum, its alloy, or a ruthenium. And said reforming machine 2 is opened for free passage by this fuel electrode 15, and the reformed gas which makes hydrogen gas a subject is supplied here. Moreover, the Ayr feed zones 17, such as a pump, are connected to an air pole 16, and the oxygen for making it react with the hydrogen in reformed gas is supplied to it.

[0023] In addition, it connects with each electrodes 15 and 16 so that a dc-battery 18 and an inverter 19 may constitute a closed circuit as an external load. Moreover, the current sensor 20 is infixed in this closed circuit. Furthermore, the motor 21 is connected to the inverter 19. Let this motor 21 be a source of power for transit of a car.

[0024] The oxidation reaction through the ionization and the electrolyte membrane of hydrogen which are produced with the above-mentioned fuel electrode 15 is not produced about all the hydrogen gas supplied to the fuel cell 1, and the reaction effectiveness is dozens of %, therefore it is contained in exhaust gas from the fuel electrode 15 side, unused inflammable gas, i.e., hydrogen gas. In order to use this effectively, and to return the exhaust gas by the side of a fuel electrode 15 to said combustion section 6, the return tubing 22 is arranged at the condition of having opened a fuel cell 1 and the combustion section 6 for free passage. Moreover, the flow control valve 23 for controlling the flow rate of the gas which flows that interior is infixed in the pars intermedia of this return tubing 22. In addition, this flow rate value regulator valve 23 is constituted so that that opening may be controlled electrically. Furthermore, this return tubing 22 is constituted so that the gas which flows that interior can be discharged outside suitably, without supplying the combustion section 6.

[0025] The electronic control (ECU) 24 for controlling the supply of a reforming fuel and the supply of partial oxidation Ayr to said evaporator 7 is formed. This electronic control 24 is the so-called microcomputer which makes a subject a processing unit (CPU), storage (RAM, ROM), and an input/output interface, and the output signal of said current sensor 20, the detecting signal of said temperature sensors 46 and 47, and the detecting signal of said pressure sensor 48 are inputted as control data. And it calculates based on the data beforehand remembered to be these input data, a control signal is outputted to said pump 11 and air pump 13, and the amount of supply of a reforming fuel and the amount of supply of partial oxidation Ayr are controlled.

[0026] Explanation of fundamental actuation of the reforming machine 2 mentioned above supplies the mixed liquor of the methanol and water which are a reforming fuel to an evaporator 7 with the liquid supply pump 11. on the other hand, a combustion methanol sprays on a combustion chamber 24 with an injector 9 -- having -- or this -- simultaneously -- or the exhaust gas which changes to this and contains unused hydrogen gas is supplied from the return tubing 22. Moreover, air is supplied by the air pump 10 as susceptibility-of-substances-to-burn gas. The heating fuel and air which consist of this combustion methanol and/or unused hydrogen gas are oxidized under an oxidation catalyst, namely, it burns, and heat is generated. With the heat, mixed liquor evaporates and the mixed steam of a methanol and water arises.

[0027] The mixed steam produced in the evaporator 7 is sent to the reforming section 4. The steam-reforming reaction of a methanol and water arises according to the copper system catalyst prepared in this reforming section 4, and the reformed gas which uses hydrogen gas and the choke damp as a principal component arises. Moreover, the partial oxidation reforming reaction of the air and the methanol which could come, simultaneously were supplied to the reforming section 4 from the air pump 13 arises. This partial oxidation reforming reaction is expressed with (2) types mentioned above, consequently hydrogen gas and the choke damp produce it.

[0028] The steam-reforming reaction of a methanol is endothermic reaction, to this, by controlling a reaction so that the amount of endoergic and calorific value in these reactions become equal, since the partial oxidation reforming reaction of a methanol is exothermic reaction, the heat balance in the reforming section 4 is made to balance, and the temperature of the reforming section 4 is maintained almost uniformly. Therefore, since there are no receipts and payments of the heat in the reforming section 4, the heat produced in said combustion section 6 is chiefly used for heating and evaporation of a reforming fuel.

[0029] Theoretically, although the gas produced in the reforming section 4 is hydrogen gas and choke damp, carbon monoxide gas produces it only (about 1%) in fact. In case reformed gas passes CO oxidation section 5, the greater part of this carbon monoxide gas reacts with the oxygen in the air supplied from the Ayr feed zone 14, and it serves as a carbon dioxide. in this way, hydrogen -- while the reformed gas made into rich gas is sent to the fuel electrode 15 in a fuel cell 1 and produces a hydrogen ion and an electron in the reaction layer, the hydrogen ion penetrates an electrolyte membrane, reacts with oxygen by the air pole 16 side, and produces water. Moreover, an electron produces power through an external load.

[0030] In order to maintain almost uniformly the temperature in the reforming section 4 in the reforming process mentioned above, it controls as follows, the amount of oxygen of supply Ayr, i.e., amount, for a partial oxidation reforming reaction. Drawing 1 is a flow chart for explaining the example of control, and computes the amount of partial oxidation Ayr based on reforming fuel quantity (step 1). Since it is equivalent to the hydrogen capacity needed with a fuel cell 1, the reforming fuel quantity Fk (mol/s) is computed based on the load of a fuel cell 1.

[0031] Moreover, the heat balance accompanying a reforming reaction balances by being as the amount of endoergic and calorific value at the time of reforming a methanol by steam reforming and partial oxidation reforming being shown in (1) type and (2) types which were mentioned above, carrying out partial oxidation

reforming of about 21% of the methanol supplied to the reforming section 4, and carrying out steam reforming of about 79% which remains. In order to carry out oxidation reforming of the one more-mol methanol, as shown in (2) types, 1/2-mol oxygen is needed. Therefore, the amount Fpo (l/s) of partial oxidation Ayr needed to the reforming fuel of Fk (mol/s) is calculated by the degree type.
Fpo(l/s) =0.105xFk(mol/s) x22.4(l/mol) x100/21x -- 298/273, "100/21" is air content conversion of the amount of need oxygen, and is amendment of the volume at the time of making a room temperature into 25 degrees C "298/273" here.
[0032] Since there will be time amount for transportation of a reforming fuel and dynamic characteristics in an evaporator 7 by the time change of the reforming reaction accompanying it arises when changing the amount of a reforming fuel, amendment based on this is performed (step 21). First, amendment of the delay resulting from transportation of a reforming fuel is a time delay t0 If it carries out, it will amend as Fpo1=Fpo (t-t0). namely, time delay t0 only -- the value computed as an amount of Ayr at the former time is adopted as an amount of partial oxidation Ayr at present. Moreover, when the dynamic characteristics of an evaporator 7 is assumed to be first-order lag, it is Fpo2(l/s) =Fpo2oldxtau/(DT+tau) +Fpo1xDT/(DT+tau). It comes out. DT is a control period, and tau is an amount showing extent of the delay of first-order lag here, and Fpo2old is the hysteresis in front of 1 control period of Fpo2 further.
[0033] Next, the amount of partial oxidation Ayr based on the temperature detected with the temperature sensor 47 by the side of the exhaust port 45 in the reforming section 4 is amended (step 3). If the example is shown, it will be Fpo3=Fpo2+Kpx(Trot-Tro)+ Kixsigma (Trot-Tro).
It comes out. Here, it is Kp. And Ki It is a control parameter, Trot is the target temperature by the side of discharge of the reforming section 4, Tro is the temperature detected with the temperature sensor 47 further, and sigma (Trot-Tro) is the target temperature Ttot. It is the addition value of deflection with the detection temperature Tro. That is, by decreasing the amount of partial oxidation Ayr, and increasing the amount of partial oxidation Ayr, in being low on the contrary, when the detected discharge side temperature is high, the amount of partial oxidation Ayr is controlled so that the detected temperature turns into target temperature.
[0034] Furthermore based on the temperature by the side of the input of the reforming section 4, the amount of partial oxidation Ayr is amended (step 4). Since degradation of a reforming catalyst becomes remarkable at the elevated temperature beyond predetermined temperature, this aims at preventing degradation of the catalyst resulting from a temperature rise. If the example is shown, the operation of Fpo4=KdecxFpo3 will amend the value calculated at step 3. Here, it is Kdec. It is the function of the temperature Tri (degree C) detected by the temperature sensor 46 by the side of the input 43 of the reforming section 4, and the value shown in drawing 4 as an example is adopted. A partial oxidation reforming reaction is controlled and the folding point temperature shown in drawing 4 is reduced by target temperature by whenever [catalyst temperature], when the reforming fuel vapor temperature which is a catalyst de-activation threshold by the abnormality elevated temperature, therefore is supplied to a catalyst bed 41 is high. In addition, an example of the temperature distribution in the catalyst bed 41 of the reforming section 4 is shown in drawing 3 as a reference value.
[0035] And the amount Fpo4 of partial oxidation Ayr amended as mentioned above A command signal is outputted to an air pump 13 in order to supply the reforming section 4 (step 5). In that case, if the pressure by the side of the inflow of the reforming section 4 is high, since it is necessary to enlarge the output of an air pump 13, it is the following, and the command value over an air pump 13 is made and set up. First, with the pressure sensor 48 formed in the exhaust port 45 side of the reforming section 4, a pressure is detected and the pressure by the side of the feed hopper 43 of the reforming section 4 of partial oxidation Ayr is presumed based on the detection value. Therefore, this pressure is the supply quantity of state of the oxygen in this invention. And an air-pump command value is set up based on the map of the partial oxidation Ayr amount of supply and the air-pump command value which made the parameter the presumed pressure. An example of the map is shown in drawing 5 . Therefore, since the output of an air pump 13 becomes large according to it according to there being many amounts of the reforming fuel vapor supplied from an evaporator 7 to the reforming section 4 even if it is cases, like the pressure by the side of the feed hopper 43 is high, the oxygen of the amount needed for a partial oxidation reforming reaction can be supplied the neither more nor less.
[0036] Since the oxygen supply with which a partial oxidation reforming reaction is presented based on the amount of a reforming fuel, the amount of theoretical endoergic in a steam-reforming reaction, and the theoretical calorific value in a partial oxidation reforming reaction is set up according to the control unit concerning this invention as mentioned above, the amount of endoergic and calorific value in the reforming section 4 can balance, and that temperature can be maintained almost uniformly to target temperature.

Especially in the example mentioned above, since the amount of Ayr based on the temperature by the side of transportation of a reforming fuel, the amendment of the amount of Ayr based on the delay of a reaction, supply of the reforming section 4, and discharge is amended reforming effectiveness not only improves, but the amount of oxygen, i.e., extent of a partial oxidation reforming reaction, boiled for a partial oxidation reforming reaction becomes as a target, consequently the temperature of the reforming section 4 is set as the temperature which maintains a catalyst to an active state, and it can obtain the reformed gas of high quality. In the example furthermore mentioned above, since the command value over an air pump 13 is set up based on the pressure the supply part 43, i.e., feed hopper of the reforming section 4, side of partial oxidation Ayr was presumed to be, it can supply to the reforming section 4, Ayr of an amount, i.e., the oxygen, computed or amended, consequently the rate of a partial oxidation reforming reaction becomes exact, and the temperature of the reforming section 4 is maintained almost uniformly by target temperature.

[0037] When the relation between this invention and the example mentioned above is explained here, the function of step 1 shown in drawing 1 is equivalent to the amount decision means of oxygen of claim 1, and the function of step 2 is equivalent to the delay amendment means of claim 2. Furthermore said temperature sensors 46 and 47 are equivalent to the temperature detection means of claim 3, and steps 3 and 4 are equivalent to a temperature compensation means. And about claim 4, the function of step 5 shown in drawing 1 is equivalent to a presumed means and a command value setting means.

[0038] In addition, although the example mentioned above showed the example which applied this invention to the control unit for the reforming machine for supplying the gas used as a fuel to a fuel cell 1, this invention is not limited to the example described above, and the equipment which supplies reformed gas can be chosen if needed. Moreover, although the methanol was shown as a reforming fuel, the reforming machine of this invention may be constituted so that other hydrocarbons may be reformed. Although the supply quantity of state of partial oxidation Ayr was made into the pressure by the side of supply of the reforming section in the example furthermore mentioned above, you may be other quantity of states, such as the rate of flow of Ayr.

[0039] Moreover, although [the above-mentioned example] the pressure by the side of supply is presumed based on the pressure by the side of discharge of the reforming section, in this invention, carrying out direct detection of the pressure of the discharge part to the reforming section of partial oxidation Ayr is also included in presumption of the supply quantity of state of partial oxidation Ayr. It is good also as furthermore presuming the supply quantity of state of partial oxidation Ayr from the outlet pressure of the body of a reforming machine by this invention.

[0040]

[Effect of the Invention] Since the amount of the oxygen with which the business of a partial oxidation reforming reaction is presented is determined based on the amount, and the amount of theoretical endoergic and theoretical calorific value accompanying a reforming reaction of the reforming fuel which should be carried out reforming according to invention of claim 1 as explained above The temperature of the part which the amount of endoergic and calorific value accompanying a reforming reaction are made to balance, and a reforming reaction produces can be maintained to predetermined temperature, consequently a reforming reaction is advanced good, the fuel of high quality is obtained and the thing of it can be carried out.

[0041] Moreover, since according to invention of claim 2 the amount of supply oxygen is amended according to the time delay of fluctuation of the reforming reaction accompanying fluctuation of the amount when the amount of a reforming fuel has fluctuation, the temperature of the part which a reforming reaction produces is maintained still more correctly, and the fuel of the high quality which changed the gestalt can be obtained.

[0042] Since the oxygen supply with which oxidation reaction is presented is amended based on the temperature of the part which a reforming reaction produces according to invention of claim 3, the temperature of the part which a reforming reaction produces is controlled still more correctly, consequently a reforming reaction is stabilized, and the fuel of the high quality which changed the gestalt can be obtained.

[0043] And since in outputting the command signal for supplying the oxygen of the amount determined with the amount decision means of oxygen according to invention of claim 4 quantity of states, such as a supply pressure of oxygen, are presumed and an oxygen supply command value is set up based on the estimate, the amount of supply of oxygen becomes exact, consequently a reforming reaction is stabilized, and the fuel of the high quality which changed the gestalt can be obtained.

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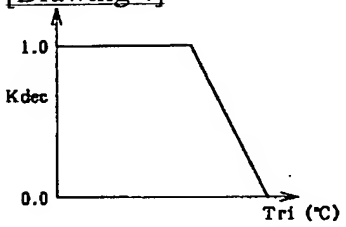
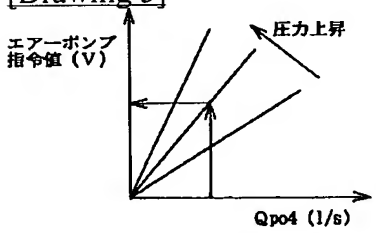
DRAWINGS

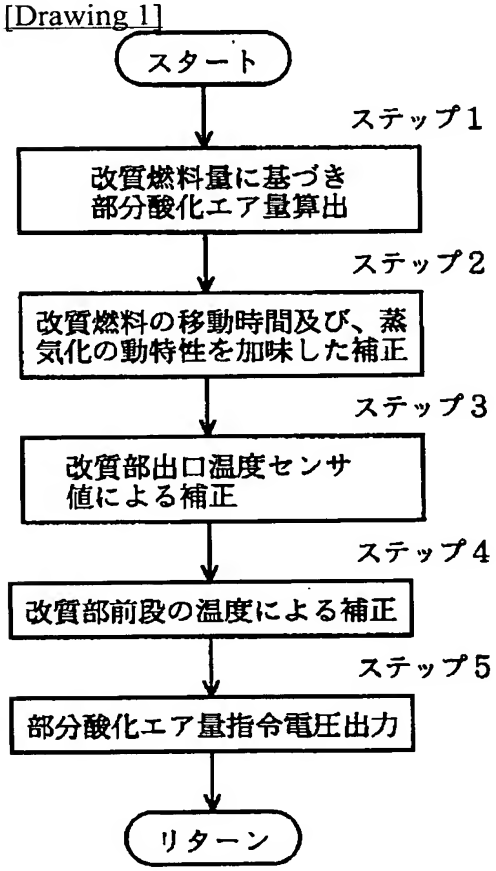
[Drawing 4]



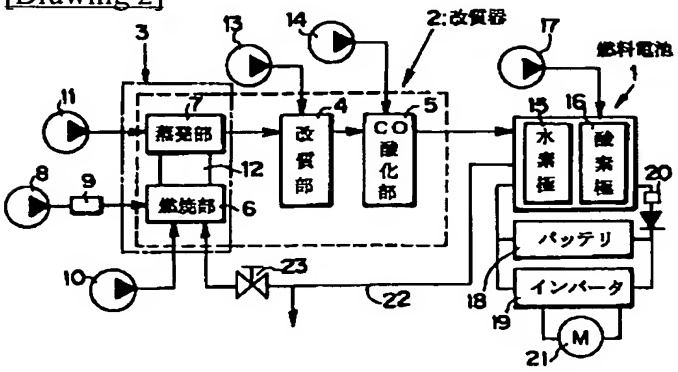
[Drawing 5]



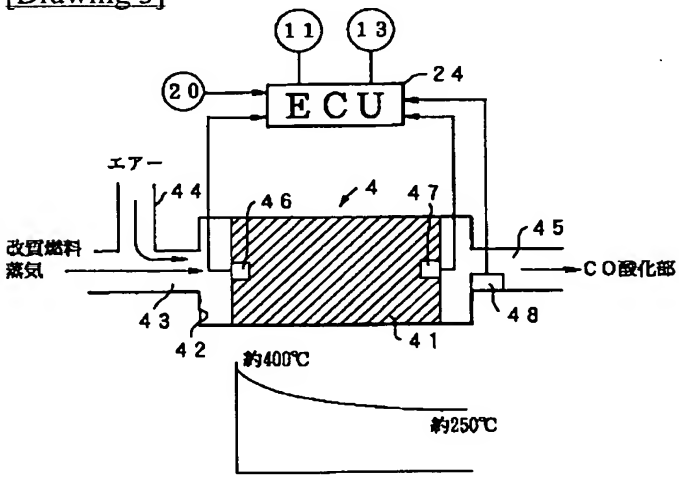
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CORRECTION OR AMENDMENT

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[Procedure revision]
[Filing Date] July 12, Heisei 17 (2005. 7.12)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[The contents of amendment]
[Claim(s)]
[Claim 1]
In the control unit of the reforming machine which reforms a reforming fuel to the fuel of a predetermined gestalt by the reforming reaction accompanied by endoergic, and the partial oxidation reforming reaction accompanied by generation of heat,
The control unit of the reforming machine characterized by providing the following An amount decision means of oxygen to determine the amount of the oxygen supplied for said partial oxidation reforming reaction based on the reforming fuel quantity which should be reformed to the fuel of said predetermined gestalt, the amount of theoretical endoergic in the reforming reaction accompanied by endoergic [said], and the theoretical calorific value in said partial oxidation reforming reaction A delay amendment means to amend the amount of oxygen determined with said amount decision means of oxygen based on the time lag from supply of said reforming fuel to a reforming reaction
[Claim 2]
In the control unit of the reforming machine which reforms a reforming fuel to the fuel of a predetermined gestalt by the reforming reaction accompanied by endoergic, and the partial oxidation reforming reaction accompanied by generation of heat,
The control unit of the reforming machine characterized by providing the following An amount decision means of oxygen to determine the amount of the oxygen supplied for said partial oxidation reforming reaction based on the reforming fuel quantity which should be reformed to the fuel of said predetermined gestalt, the amount of theoretical endoergic in the reforming reaction accompanied by endoergic [said], and the theoretical calorific value in said partial oxidation reforming reaction A temperature detection means to

detect the temperature of the part which the reforming reaction of a reforming fuel produces A temperature compensation means to amend the amount of oxygen determined with said amount decision means of oxygen based on the detected temperature
[Claim 3]
In the control unit of the reforming machine which reforms a reforming fuel to the fuel of a predetermined gestalt by the reforming reaction accompanied by endoergic, and the partial oxidation reforming reaction accompanied by generation of heat,
The control unit of the reforming machine characterized by providing the following An amount decision means of oxygen to determine the amount of the oxygen supplied for said partial oxidation reforming reaction based on the reforming fuel quantity which should be reformed to the fuel of said predetermined gestalt, the amount of theoretical endoergic in the reforming reaction accompanied by endoergic [said], and the theoretical calorific value in said partial oxidation reforming reaction A presumed means to presume the supply quantity of state of the oxygen for said partial oxidation reforming reaction to the part which the reforming reaction of said reforming fuel produces A command value setting means to set up the command value which supplies the oxygen for a partial oxidation reforming reaction based on the amount of oxygen determined with the oxygen supply quantity of state presumed with this presumed means, and said amount decision means of oxygen
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0008
[Method of Amendment] Modification
[The contents of amendment]
[0008]
[Means for Solving the Problem and its Function]
It notes that a partial oxidation reaction arises according to the amount of oxygen introduced into the reforming section in order that this invention may attain the above-mentioned purpose. The inside of the amount required of the reforming fuel with which an endoergic reforming reaction and a partial oxidation reforming reaction are presented in the amount of oxygen, It is characterized by constituting so that it may determine based on the reforming fuel quantity with which the partial oxidation reforming reaction for which it opted based on the ratio of the amount of theoretical endoergic in an endoergic reforming reaction and the theoretical calorific value in a partial oxidation reforming reaction is presented. In the control unit of the reforming machine to which invention of claim 1 more specifically reforms a reforming fuel to the fuel of a predetermined gestalt by the reforming reaction accompanied by endoergic, and the partial oxidation reforming reaction accompanied by generation of heat An amount decision means of oxygen to determine the amount of the oxygen supplied for said partial oxidation reforming reaction based on the reforming fuel quantity which should be reformed to the fuel of said predetermined gestalt, the amount of theoretical endoergic in the reforming reaction accompanied by endoergic [said], and the theoretical calorific value in said partial oxidation reforming reaction, It is characterized by having a delay amendment means to amend the amount of oxygen determined with said amount decision means of oxygen based on the time lag from supply of said reforming fuel to a reforming reaction.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0009
[Method of Amendment] Modification
[The contents of amendment]
[0009]
Moreover, invention of claim 2 sets a reforming fuel to the control unit of the reforming machine reformed to the fuel of a predetermined gestalt by the reforming reaction accompanied by endoergic, and the partial oxidation reforming reaction accompanied by generation of heat. An amount decision means of oxygen to determine the amount of the oxygen supplied for said partial oxidation reforming reaction based on the reforming fuel quantity which should be reformed to the fuel of said predetermined gestalt, the amount of theoretical endoergic in the reforming reaction accompanied by endoergic [said], and the theoretical calorific value in said partial oxidation reforming reaction, It is characterized by having a temperature detection means to detect the temperature of the part which the reforming reaction of a reforming fuel produces, and a temperature compensation means to amend the amount of oxygen determined with said amount decision means of oxygen based on the detected temperature.

[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0010
[Method of Amendment] Modification
[The contents of amendment]
[0010]
In the control unit of the reforming machine to which invention of claim 3 reforms a reforming fuel to the fuel of a predetermined gestalt by the reforming reaction accompanied by endoergic, and the partial oxidation reforming reaction accompanied by generation of heat An amount decision means of oxygen to determine the amount of the oxygen supplied for said partial oxidation reforming reaction based on the reforming fuel quantity which should be reformed to the fuel of said predetermined gestalt, the amount of theoretical endoergic in the reforming reaction accompanied by endoergic [said], and the theoretical calorific value in said partial oxidation reforming reaction, A presumed means to presume the supply quantity of state of the oxygen for said partial oxidation reforming reaction to the part which the reforming reaction of said reforming fuel produces, It is characterized by having a command value setting means to set up the command value which supplies the oxygen for a partial oxidation reforming reaction, based on the amount of oxygen determined with the oxygen supply quantity of state presumed with this presumed means, and said amount decision means of oxygen.
[Procedure amendment 5]
[Document to be Amended] Specification
[Item(s) to be Amended] 0011
[Method of Amendment] Deletion
[The contents of amendment]

[Procedure amendment 6]
[Document to be Amended] Specification
[Item(s) to be Amended] 0012
[Method of Amendment] Modification
[The contents of amendment]
[0012]
According to invention of claim 1, therefore, the amount of the oxygen with which the business of a partial oxidation reforming reaction is presented Since it is determined based on the amount, and the amount of theoretical endoergic and theoretical calorific value accompanying a reforming reaction of the reforming fuel which should be carried out reforming and the amount of supply oxygen is amended according to the time delay of fluctuation of the reforming reaction accompanying fluctuation of the amount of a reforming fuel While the temperature of the part which the amount of endoergic and calorific value accompanying a reforming reaction are made to balance, and a reforming reaction produces is maintainable to predetermined temperature The fuel of the high quality which the temperature of the part which a reforming reaction produces was maintained still more correctly, consequently the reforming reaction was advanced good, and changed the gestalt is obtained, and the thing of it can be carried out.
[Procedure amendment 7]
[Document to be Amended] Specification
[Item(s) to be Amended] 0013
[Method of Amendment] Deletion
[The contents of amendment]

[Procedure amendment 8]
[Document to be Amended] Specification
[Item(s) to be Amended] 0014
[Method of Amendment] Modification
[The contents of amendment]
[0014]
According to invention of claim 2, the amount of the oxygen with which the business of a partial oxidation reforming reaction is presented Since the oxygen supply with which oxidation reaction is presented is amended based on the temperature of the part which is determined based on the amount, and the amount of theoretical endoergic and theoretical calorific value accompanying a reforming reaction of the reforming

fuel which should be carried out reforming, and a reforming reaction produces The temperature of the part which a reforming reaction produces is controlled still more correctly, consequently a reforming reaction is stabilized, and the fuel of the high quality which changed the gestalt can be obtained.
[Procedure amendment 9]
[Document to be Amended] Specification
[Item(s) to be Amended] 0015
[Method of Amendment] Modification
[The contents of amendment]
[0015]
According to invention of claim 3, and the amount of the oxygen with which the business of a partial oxidation reforming reaction is presented It is determined based on the amount, and the amount of theoretical endoergic and theoretical calorific value accompanying a reforming reaction of the reforming fuel which should be carried out reforming. Moreover, since in outputting the command signal for supplying the oxygen of the amount determined with the amount decision means of oxygen quantity of states, such as a supply pressure of oxygen, are presumed and an oxygen supply command value is set up based on the estimate The amount of supply of oxygen becomes exact, consequently a reforming reaction is stabilized, and the fuel of the high quality which changed the gestalt can be obtained.
[Procedure amendment 10]
[Document to be Amended] Specification
[Item(s) to be Amended] 0024
[Method of Amendment] Modification
[The contents of amendment]
[0024]
The oxidation reaction through the ionization and the electrolyte membrane of hydrogen which are produced with the above-mentioned fuel electrode 15 is not produced about all the hydrogen gas supplied to the fuel cell 1, and the reaction effectiveness is dozens of %, therefore it is contained in exhaust gas from the fuel electrode 15 side, unused inflammable gas, i.e., hydrogen gas. In order to use this effectively, and to return the exhaust gas by the side of a fuel electrode 15 to said combustion section 6, the return tubing 22 is arranged at the condition of having opened a fuel cell 1 and the combustion section 6 for free passage. Moreover, the flow control valve 23 for controlling the flow rate of the gas which flows that interior is infixed in the pars intermedia of this return tubing 22. In addition, this flow control valve 23 is constituted so that that opening may be controlled electrically. Furthermore, this return tubing 22 is constituted so that the gas which flows that interior can be discharged outside suitably, without supplying the combustion section 6.
[Procedure amendment 11]
[Document to be Amended] Specification
[Item(s) to be Amended] 0037
[Method of Amendment] Modification
[The contents of amendment]
[0037]
When the relation between this invention and the example mentioned above is explained here, the function of step 1 shown in drawing 1 is equivalent to the amount decision means of oxygen of this invention, and the function of step 2 is equivalent to the delay amendment means of this invention. Furthermore said temperature sensors 46 and 47 are equivalent to the temperature detection means of this invention, and steps 3 and 4 are equivalent to a temperature compensation means. And the function of step 5 shown in drawing 1 is equivalent to the presumed means of this invention, and a command value setting means.
[Procedure amendment 12]
[Document to be Amended] Specification
[Item(s) to be Amended] 0040
[Method of Amendment] Modification
[The contents of amendment]
[0040]
[Effect of the Invention]
As explained above, according to invention of claim 1, the amount of the oxygen with which the business of a partial oxidation reforming reaction is presented Since it is determined based on the amount, and the amount of theoretical endoergic and theoretical calorific value accompanying a reforming reaction of the

reforming fuel which should be carried out reforming and the amount of supply oxygen is amended according to the time delay of fluctuation of the reforming reaction accompanying fluctuation of the amount of a reforming fuel While the temperature of the part which the amount of endoergic and calorific value accompanying a reforming reaction are made to balance, and a reforming reaction produces is maintainable to predetermined temperature The fuel of the high quality which the temperature of the part which a reforming reaction produces was maintained still more correctly, consequently the reforming reaction was advanced good, and changed the gestalt is obtained, and the thing of it can be carried out.
[Procedure amendment 13]
[Document to be Amended] Specification
[Item(s) to be Amended] 0041
[Method of Amendment] Deletion
[The contents of amendment]

[Procedure amendment 14]
[Document to be Amended] Specification
[Item(s) to be Amended] 0042
[Method of Amendment] Modification
[The contents of amendment]
[0042]
According to invention of claim 2, the amount of the oxygen with which the business of a partial oxidation reforming reaction is presented Since the oxygen supply with which oxidation reaction is presented is amended based on the temperature of the part which is determined based on the amount, and the amount of theoretical endoergic and theoretical calorific value accompanying a reforming reaction of the reforming fuel which should be carried out reforming, and a reforming reaction produces The temperature of the part which a reforming reaction produces is controlled still more correctly, consequently a reforming reaction is stabilized, and the fuel of the high quality which changed the gestalt can be obtained.
[Procedure amendment 15]
[Document to be Amended] Specification
[Item(s) to be Amended] 0043
[Method of Amendment] Modification
[The contents of amendment]
[0043]
According to invention of claim 3, and the amount of the oxygen with which the business of a partial oxidation reforming reaction is presented It is determined based on the amount, and the amount of theoretical endoergic and theoretical calorific value accompanying a reforming reaction of the reforming fuel which should be carried out reforming. Moreover, since in outputting the command signal for supplying the oxygen of the amount determined with the amount decision means of oxygen quantity of states, such as a supply pressure of oxygen, are presumed and an oxygen supply command value is set up based on the estimate The amount of supply of oxygen becomes exact, consequently a reforming reaction is stabilized, and the fuel of the high quality which changed the gestalt can be obtained.

[Translation done.]

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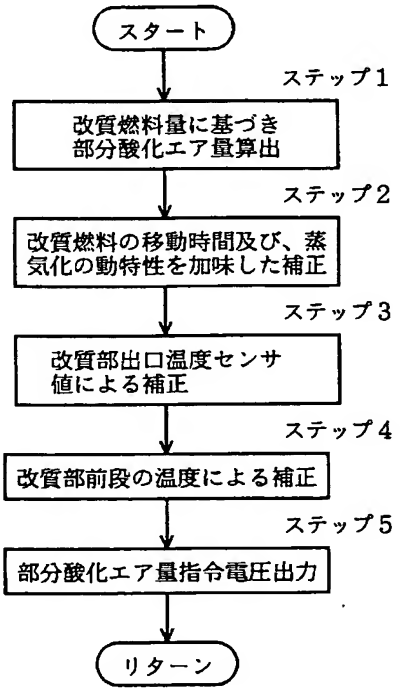
(71)出願人　000003207
トヨタ自動車株式会社
愛知県豊田市トヨタ町１番地
(72)発明者　永宮　清美
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内
(72)発明者　山下　勝司
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内
(74)代理人　100083998
弁理士　渡辺　丈夫

最終頁に続く

(54)【発明の名称】　改質器の制御装置

(57)【要約】
【課題】　部分酸化改質反応を適正に生じさせた改質反応温度を目標温度にほぼ一定に維持することのできる制御装置を提供する。
【解決手段】　吸熱を伴う改質反応と発熱を伴う部分酸化改質反応とによって改質燃料を所定の形態の燃料に改質する改質器の制御装置であって、前記部分酸化改質反応のために供給する酸素の量を、前記所定の形態の燃料に改質するべき改質燃料量と前記吸熱を伴う改質反応での理論吸熱量および前記部分酸化改質反応での理論発熱量とに基づいて決定する酸素量決定手段（ステップ１）を備えている。



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【特許請求の範囲】

【請求項１】　吸熱を伴う改質反応と発熱を伴う部分酸化改質反応とによって改質燃料を所定の形態の燃料に改質する改質器の制御装置において、

前記部分酸化改質反応のために供給する酸素の量を、前記所定の形態の燃料に改質するべき改質燃料量と前記吸熱を伴う改質反応での理論吸熱量および前記部分酸化改質反応での理論発熱量とに基づいて決定する酸素量決定手段を備えていることを特徴とする改質器の制御装置。

【請求項２】　前記酸素量決定手段で決定された酸素量を、前記改質燃料の供給から改質反応までの時間遅れに基づいて補正する遅れ補正手段を更に備えていることを特徴とする請求項１に記載の改質器の制御装置。

【請求項３】　改質燃料の改質反応の生じる部分の温度を検出する温度検出手段と、検出された温度に基づいて、前記酸素量決定手段で決定された酸素量を補正する温度補正手段とを更に備えていることを特徴とする請求項１の改質器の制御装置。

【請求項４】　前記改質燃料の改質反応が生じる部分に対する前記部分酸化改質反応のための酸素の供給状態量を推定する推定手段と、該推定手段で推定された酸素供給状態量と前記酸素量決定手段で決定された酸素量とに基づいて、部分酸化改質反応のための酸素を供給する指令値を設定する指令値設定手段とを更に備えていることを特徴とする請求項１の改質器の制御装置。

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【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、メチルアルコールなどの炭化水素および水などの改質燃料を水素リッチな改質ガスなどの所望の形態の燃料に改質する改質器に関し、特に部分酸化改質反応を併用する改質器における部分酸化改質反応を制御するための装置に関するものである。

【０００２】

【従来の技術】この種の改質器として、メタノールと水との混合蒸気を改質して水素を主体とする改質ガスを生成する構成のものが知られている。その改質器での改質反応は、主に、下記の式で表されるメタノールと水蒸気との反応により水素ガスを生じる水蒸気改質反応である。

$$CH_3OH+H_2O \rightarrow 3H_2+CO_2\ (+CO)\ -49.5\ (kJ/mol) \quad \cdots (1)$$

したがってこの水蒸気改質反応が吸熱反応であり、また改質触媒の活性温度が３００℃程度の比較的高温であるから、改質反応を継続させるためには、その反応熱を供給する必要がある。

【０００３】一方、メタノールの改質反応として、酸化反応によって水素を生じる部分酸化改質反応がある。これは、下記の式で表されるように発熱反応である。

$$CH_3OH+1/2O_2 \rightarrow 2H_2+CO_2+189.6\ (kJ/mol) \quad \cdots (2)$$

【０００４】これらの水蒸気改質反応と部分酸化改質反応とを並行して生じさせることができるから、水蒸気改質反応での吸熱を部分酸化改質反応の発熱で補うことができる。このようないわゆる部分酸化併用型の燃料電池システムが、特開平７－５７７５６号公報に記載されている。この公報に記載された発明では、コンプレッサーで加圧した空気を熱交換器で加熱した後に、改質器に導入し、部分酸化反応を生じさせる、としている。しかし、その導入する空気の量などについては特に制御の対象としていない。これは、前記の公報に記載されているシステムがいわゆる据え置き型の大型のシステムを対象とし、そのために、負荷の変動が殆どないことによるものと思われる。

【０００５】

【発明が解決しようとする課題】上に示した反応式から知られるように、水蒸気改質反応での吸熱量と部分酸化改質反応での発熱量とは大きく異なっている。したがってこれらの各反応が同時に１モルのメタノールについて生じるとすれば、発熱量が多くなって触媒温度が過剰に高温になり、その活性や耐久性が低下する可能性がある。また反対に部分酸化改質反応が低調であれば、改質触媒の温度が低下して残留メタノール量や一酸化炭素ガスの生成量が多くなる不都合がある。

【０００６】このように部分酸化改質反応を生じさせるとしても、その反応の程度によっては改質反応に異常を来すことになる。そのために、部分酸化併用型の改質器ではその部分酸化反応を適正に制御する必要があるが、上述した公報に記載された従来のシステムでは、部分酸化反応を制御するための具体的な制御対象や制御方法が全く認識されていない。そのため、上述した従来の装置では、改質部の温度を改質反応に要求される温度に安定的に維持することが困難であり、特に燃料電池などの改質燃料を消費するエネルギー変換器での負荷の変動に伴って改質燃料の量が変動する場合には、改質触媒の温度など改質部の温度が不安定になり、その結果、改質ガスの品質が低下するなどの可能性があった。

【０００７】この発明は上記の事情を背景にしてなされたものであり、部分酸化改質反応を併用する改質器の温度を改質反応に要求される温度に安定的に維持することのできる制御装置を提供することを目的とするものである。

【０００８】

【課題を解決するための手段およびその作用】この発明は、上記の目的を達成するために、部分酸化反応が改質

部に導入した酸素量に応じて生じることに着目し、その酸素量を、吸熱改質反応と部分酸化改質反応とに供される改質燃料の要求量のうち、吸熱改質反応での理論吸熱量と部分酸化改質反応での理論発熱量との比率に基づいて決定された部分酸化改質反応に供される改質燃料量に基づいて決定するように構成したことを特徴とするものである。より具体的には、請求項１の発明は、吸熱を伴う改質反応と発熱を伴う部分酸化改質反応とによって改質燃料を所定の形態の燃料に改質する改質器の制御装置において、前記部分酸化改質反応のために供給する酸素の量を、前記所定の形態の燃料に改質するべき改質燃料量と前記吸熱を伴う改質反応での理論吸熱量および前記部分酸化改質反応での理論発熱量とに基づいて決定する酸素量決定手段を備えていることを特徴とするものである。

【０００９】また請求項２の発明は、請求項１の構成に加えて、前記酸素量決定手段で決定された酸素量を、前記改質燃料の供給から改質反応までの時間遅れに基づいて補正する遅れ補正手段を更に備えていることを特徴とするものである。

【００１０】請求項３の発明は、請求項１の構成に加えて、改質燃料の改質反応の生じる部分の温度を検出する温度検出手段と、検出された温度に基づいて、前記酸素量決定手段で決定された酸素量を補正する温度補正手段とを更に備えていることを特徴とするものである。

【００１１】そして請求項４の発明は、請求項１の構成に加えて、前記改質燃料の改質反応が生じる部分に対する前記部分酸化改質反応のための酸素の供給状態量を推定する推定手段と、該推定手段で推定された酸素供給状態量と前記酸素量決定手段で決定された酸素量とに基づいて、部分酸化改質反応のための酸素を供給する指令値を設定する指令値設定手段とを更に備えていることを特徴とするものである。

【００１２】したがって請求項１の発明によれば、部分酸化改質反応の用に供される酸素の量が、改質すべき改質燃料の量および改質反応に伴う理論吸熱量と理論発熱量とに基づいて決定されるので、改質反応に伴う吸熱量と発熱量とをバランスさせて改質反応が生じる部分の温度を所定の温度に維持することができ、その結果、改質反応を良好に進行させて高品質の燃料を得ることできる。

【００１３】また請求項２の発明によれば、改質燃料の量に変動がある場合、その量の変動に伴う改質反応の変動の時間的遅れに応じて供給酸素量を補正するので、改質反応の生じる部分の温度が更に正確に維持され、形態を変更した高品質の燃料を得ることができる。

【００１４】請求項３の発明によれば、改質反応の生じる部分の温度に基づいて、酸化反応に供される酸素供給量を補正するので、改質反応の生じる部分の温度が更に正確に制御され、その結果、改質反応が安定して、形態を変更した高品質の燃料を得ることができる。

【００１５】そして請求項４の発明によれば、酸素量決定手段で決定された量の酸素を供給するための指令信号を出力するにあたり、酸素の供給圧などの状態量を推定し、その推定値に基づいて酸素供給指令値を設定するので、酸素の供給量が正確になり、その結果、改質反応が安定して、形態を変更した高品質の燃料を得ることができる。

【００１６】

【発明の実施の形態】つぎにこの発明を図に示す具体例に基づいて説明する。先ず、改質器としてメタノールおよび水を改質燃料とした改質器を使用し、かつその改質器から生じた改質ガスを他の形態のエネルギーに変換するエネルギー変換器として燃料電池を使用したシステムについて説明する。図２はその一例を模式的に示しており、燃料電池１の燃料極側に、改質器２が接続されている。この改質器２は、改質燃料であるメタノールと水との混合物を水素と二酸化炭素とを主成分とする改質ガスに改質するものであって、改質燃料を加熱する加熱部３と、改質部４と、ＣＯ酸化部５とを備えている。

【００１７】加熱部３は、改質燃料を加熱してメタノールと水との混合蒸気を生じさせるためのものであり、加熱のための熱を発生させる燃焼部６とその熱によって改質燃料を蒸発させる蒸発部７とによって構成されている。その燃焼部６としては、加熱燃料をバーナによって燃焼させる構造のものや加熱燃料を触媒によって酸化させる構成のものなどを採用することができる。したがってこの燃焼部６には、加熱燃料の一例であるメタノールを供給するポンプ８がインジェクタ９を介して接続され、また支燃ガスの一例である空気を供給するエアー供給部１０が設けられている。このエアー供給部１０は具体的には、エアーポンプによって構成されている。

【００１８】また、蒸発部７には、メタノールと水との混合液を供給する改質燃料供給部としてポンプ１１が接続されている。そしてこの蒸発部７と前記燃焼部６とは、熱交換器１２によって熱伝達可能に連結されている。

【００１９】前記改質部４は、主としてメタノールの改質反応によって水素を主成分とする改質ガスを発生させるように構成されている。その改質反応は、上記の（１）式で示されるいわゆる水蒸気改質反応と、（２）式で示されるいわゆる部分酸化改質反応とであり、これらの反応を生じさせるために、図３に示すように、活性温度が例えば２８０～３００℃程度の銅系の触媒からなる触媒層４１がチャンバー４２内に設けられており、そのチャンバー４２の供給口４３に前記蒸発部７が接続されている。またその供給口４３には、部分酸化反応のために酸素を供給する部分酸化エアー供給管４４が接続されている。そしてこの部分酸化エアー供給管４４にエアーポンプ１３が接続されている。

【００２０】また、チャンバー４２の供給口４３側と排出口４５側とには、触媒層４１の温度を検出して信号を出力する温度センサ４６，４７がそれぞれ配置されている。さらに排出口４５側には、圧力センサ４８が配置されている。

【００２１】上記の（１）式および（２）式で示す改質反応は理想状態の反応であり、また二酸化炭素は可逆的に一酸化炭素に変化するので、実際には、不可避的に一酸化炭素ガスが改質ガスに混入する。この一酸化炭素は、燃料電池１における燃料極の触媒を被毒する原因となるので、これを除去するためにＣＯ酸化部５が設けられている。このＣＯ酸化部５は、ＣＯ酸化触媒（図示せず）を備えるとともに、エアー供給部１４を備えており、改質部４で生成させた改質ガスを通過させることにより、改質ガスに含まれる一酸化炭素を空気中の酸素によって酸化させるように構成されている。

【００２２】一方、燃料電池１は、一例として、プロトン透過性のある高分子膜を電解質とし、その電解質膜を挟んで燃料極（水素極）１５と空気極（酸素極）１６とを設け、このような構成の単電池を多数直並列に接続して構成されている。各電極１５，１６は、拡散層と反応層とによって構成され、燃料極１５における反応層は、例えば炭素に白金やその合金あるいはルテニウムなどの触媒を担持させた多孔質構造とされている。そしてこの燃料極１５に前記改質器２が連通され、ここに水素ガスを主体とする改質ガスが供給されるようになっている。また空気極１６には、ポンプなどのエアー供給部１７が接続され、改質ガス中の水素と反応させるための酸素を供給するようになっている。

【００２３】なお、各電極１５，１６には、外部負荷としてバッテリー１８やインバータ１９が閉回路を構成するように接続されている。またこの閉回路には、電流センサ２０が介装されている。さらにインバータ１９には、モータ２１が接続されている。このモータ２１は、例えば車両の走行のための動力源とされる。

【００２４】上記の燃料極１５で生じる水素のイオン化および電解質膜を介した酸化反応は、燃料電池１に供給した水素ガスの全てについて生じる訳ではなく、その反応効率は、数十％であり、したがって燃料極１５側から排ガスには未利用の可燃性ガスすなわち水素ガスが含まれている。これを有効利用するために、燃料極１５側の排ガスを前記燃焼部６に戻すためにリターン管２２が、燃料電池１と燃焼部６とを連通した状態に配置されている。またこのリターン管２２の中間部には、その内部を流動するガスの流量を制御するための流量調整弁２３が介装されている。なお、この流量値調整弁２３はその開度を電気的に制御するように構成されている。さらに、このリターン管２２は、その内部を流動するガスを、燃焼部６に供給せずに適宜に外部に排出できるように構成されている。

【００２５】前記蒸発部７に対する改質燃料の供給や部分酸化エアーの供給を制御するための電子制御装置（ＥＣＵ）２４が設けられている。この電子制御装置２４は、演算処理装置（ＣＰＵ）と記憶装置（ＲＡＭ，ＲＯＭ）と入出力インターフェースとを主体とするいわゆるマイクロコンピュータであって、制御データとして前記電流センサ２０の出力信号と、前記温度センサ４６，４７の検出信号と、前記圧力センサ４８の検出信号とが入力されている。そしてこれらの入力データと予め記憶しているデータとに基づいて演算をおこなって制御信号を前記ポンプ１１やエアーポンプ１３に出力し、改質燃料の供給量や部分酸化エアーの供給量を制御するようになっている。

【００２６】上述した改質器２の基本的な動作について説明すると、改質燃料であるメタノールと水との混合液が、給液ポンプ１１により蒸発部７に供給される。これに対して燃焼室２４には、燃焼メタノールがインジェクタ９によって噴霧され、あるいはこれと同時にもしくはこれに替えて未利用水素ガスを含む排ガスがリターン管２２から供給される。また支燃ガスとして空気がエアーポンプ１０によって供給される。この燃焼メタノールおよび／または未利用水素ガスからなる加熱燃料と空気とが酸化触媒の下に酸化反応し、すなわち燃焼し、熱を発生する。その熱によって混合液が蒸発し、メタノールと水との混合蒸気が生じる。

【００２７】蒸発部７で生じた混合蒸気は、改質部４に送られる。この改質部４に設けられた銅系触媒によってメタノールと水との水蒸気改質反応が生じ、水素ガスおよび二酸化炭素ガスを主成分とする改質ガスが生じる。またこれと同時に、エアーポンプ１３から改質部４に供給された空気とメタノールとの部分酸化改質反応が生じる。この部分酸化改質反応は上述した（２）式で表され、その結果、水素ガスと二酸化炭素ガスとが生じる。

【００２８】メタノールの水蒸気改質反応は吸熱反応であり、これに対してメタノールの部分酸化改質反応は発熱反応であるから、これらの反応における吸熱量と発熱量とが等しくなるように反応を制御することにより、改質部４での熱収支をバランスさせ、改質部４の温度がほぼ一定に維持される。したがって改質部４での熱の出入りがないので、前記燃焼部６で生じさせた熱は、専ら改質燃料の加熱・蒸発に使用される。

【００２９】改質部４で生じるガスは、原理的には、水素ガスと二酸化炭素ガスであるが、実際には一酸化炭素ガスがわずか（１％程度）生じる。この一酸化炭素ガスの大半は、改質ガスがＣＯ酸化部５を通過する際にエアー供給部１４から供給される空気中の酸素と反応して二酸化炭素となる。こうして水素リッチなガスとされた改質ガスが燃料電池１における燃料極１５に送られ、その反応層で水素イオンと電子とを生じるとともに、その水素イオンが電解質膜を透過して空気極１６側で酸素と反

応し、水を生じる。また電子は外部負荷を通って動力を生じさせる。

【００３０】上述した改質過程での改質部４における温度をほぼ一定に維持するために、部分酸化改質反応のための酸素量すなわち供給エアー量を以下のように制御する。図１はその制御例を説明するためのフローチャートであって、改質燃料量に基づいて部分酸化エアー量を算出する（ステップ１）。その改質燃料量Ｆｋ（mol/s）は、燃料電池１で必要とする水素ガス量に相当しているから、燃料電池１の負荷に基づいて算出される。

【００３１】また、メタノールを水蒸気改質および部分酸化改質によって改質した場合の吸熱量と発熱量とは、前述した（１）式および（２）式に示すとおりであり、したがって改質部４に供給したメタノールの約２１％を部分酸化改質し、かつ残る約７９％を水蒸気改質することにより、改質反応に伴う熱収支がバランスする。さらに１モルのメタノールを酸化改質するためには、（２）式に示されるように１／２モルの酸素を必要とする。したがってＦｋ（mol/s）の改質燃料に対して必要とする部分酸化エアー量Ｆpo（l/s）は、次式で求められる。

Ｆpo（l/s）＝0.105×Ｆｋ（mol/s）×22.4（l/mol）×100/21×298/273

ここで、「100/21」は必要酸素量の空気量換算であり、また「298/273」は室温を２５℃とした場合の体積の補正である。

【００３２】改質燃料の量を変化させた場合、それに伴う改質反応の変化が生じるまでには、改質燃料の輸送のための時間および蒸発部７での動特性があるため、これに基づく補正をおこなう（ステップ２１）。先ず、改質燃料の輸送に起因する遅れの補正は、遅れ時間をｔ０とすると、

Ｆpo1＝Ｆpo(t-t0)

として補正する。すなわち、遅れ時間ｔ０だけ以前の時点のエアー量として算出される値を現時点の部分酸化エアー量として採用する。また、蒸発部７の動特性を一次遅れと仮定すると、

Ｆpo2(1/s)＝Ｆpo2old×τ／（ＤＴ＋τ）＋Ｆpo1×ＤＴ／（ＤＴ＋τ）

である。ここで、ＤＴは制御周期であり、またτは一次遅れの遅れの程度を表す量であり、さらにＦpo2oldはＦpo2の一制御周期前の履歴である。

【００３３】つぎに、改質部４での排出口４５側の温度センサ４７で検出した温度に基づく部分酸化エアー量の補正をおこなう（ステップ３）。その一例を示せば、

Ｆpo3＝Ｆpo2＋Kp×（Trot－Tro）＋Ki×Σ（Trot－Tro)

である。ここで、Kp およびKi は制御パラメータであり、Trotは改質部４の排出側での目標温度であり、さらにTroは温度センサ４７で検出された温度であり、そしてΣ（Trot－Tro）は目標温度Ttot と検出温度Troとの偏差の積算値である。すなわち検出された排出側温度が高い場合には、部分酸化エアー量を減少させ、また反対に低い場合には部分酸化エアー量を増大させることにより、検出された温度が目標温度となるように部分酸化エアー量を制御する。

【００３４】さらに改質部４の流入口側の温度に基づいて部分酸化エアー量を補正する（ステップ４）。これは、改質触媒の劣化が所定温度以上の高温で顕著になるので、温度上昇に起因する触媒の劣化を防止することを目的とするものである。その一例を示せば、

Ｆpo4＝Kdec×Ｆpo3

の演算により、ステップ３で求めた値を補正する。ここで、Kdec は改質部４の流入口４３側の温度センサ４６によって検出された温度Tri（℃）の関数であり、一例として図４に示す値が採用される。図４に示す屈曲点温度は、異常高温による触媒劣化しきい値であり、したがって触媒層４１に供給される改質燃料蒸気温度が高い場合には、部分酸化改質反応が抑制されて、触媒温度で目標温度に低下させられる。なお、改質部４の触媒層４１における温度分布の一例を図３に参考値として示してある。

【００３５】そして以上のようにして補正された部分酸化エアー量Ｆpo4 を改質部４に供給するべくエアーポンプ１３に対して指令信号を出力する（ステップ５）。その場合、改質部４の流入側の圧力が高ければ、エアーポンプ１３の出力を大きくする必要があるので、エアーポンプ１３に対する指令値を以下のようにして設定する。先ず、改質部４の排出口４５側に設けた圧力センサ４８によって圧力を検出し、その検出値に基づいて部分酸化エアーの改質部４の供給口４３側での圧力を推定する。したがってこの圧力がこの発明における酸素の供給状態量である。そしてその推定した圧力をパラメータとした部分酸化エアー供給量とエアーポンプ指令値とのマップに基づいてエアーポンプ指令値を設定する。そのマップの一例を図５に示してある。したがって蒸発部７から改質部４に対して供給する改質燃料蒸気の量が多いことによりその供給口４３側での圧力が高いなどの場合であっても、それに応じてエアーポンプ１３の出力が大きくなるので、部分酸化改質反応に必要とする量の酸素を過不足なく供給することができる。

【００３６】上述したようにこの発明に係る制御装置によれば、改質燃料の量と水蒸気改質反応での理論吸熱量および部分酸化改質反応での理論発熱量とに基づいて部分酸化改質反応に供される酸素供給量を設定するので、改質部４での吸熱量と発熱量とがバランスし、その温度を目標温度にほぼ一定に維持することができる。特に上述した例では、改質燃料の輸送や反応の遅れに基づくエアー量の補正や改質部４の供給側や排出側の温度に基づくエアー量の補正をおこなうので、部分酸化改質反応のためにの酸素量すなわち部分酸化改質反応の程度が目標

どおりとなり、その結果、改質部４の温度が触媒を活性状態に維持する温度に設定され、改質効率が向上するのみならず、高品質の改質ガスを得ることができる。さらに上述した例では、部分酸化エアーの供給箇所すなわち改質部４の供給口４３側の推定された圧力に基づいてエアーポンプ１３に対する指令値を設定するから、算出もしくは補正された量のエアーすなわち酸素を改質部４に供給でき、その結果、部分酸化改質反応の割合が正確になって改質部４の温度が目標とする温度にほぼ一定に維持される。

【００３７】ここでこの発明と上述した具体例との関係を説明すると、図１に示すステップ１の機能が請求項１の酸素量決定手段に相当し、またステップ２の機能が請求項２の遅れ補正手段に相当する。さらに前記温度センサ４６，４７が請求項３の温度検出手段に相当し、ステップ３，４が温度補正手段に相当する。そして請求項４に関しては、図１に示すステップ５の機能が推定手段および指令値設定手段に相当する。

【００３８】なお、上述した例では、燃料電池１に燃料となるガスを供給するための改質器を対象とする制御装置にこの発明を適用した例を示したが、この発明は、以上述べた具体例に限定されないのであって、改質ガスを供給する装置は必要に応じて選択することができる。また、改質燃料としてメタノールを示したが、この発明の改質器は他の炭化水素を改質するように構成したものであってもよい。さらに上述した例では、部分酸化エアーの供給状態量を改質部の供給側の圧力としたが、エアーの流速などの他の状態量であってもよい。

【００３９】また、上記の具体例では、改質部の排出側の圧力に基づいて供給側での圧力を推定することとしたが、この発明では、部分酸化エアーの改質部に対する吐出部の圧力を直接検出することも部分酸化エアーの供給状態量の推定に含まれる。さらにこの発明では、改質器本体の出口圧から部分酸化エアーの供給状態量を推定することとしてもよい。

【００４０】

【発明の効果】以上説明したように請求項１の発明によれば、部分酸化改質反応の用に供される酸素の量が、改質すべき改質燃料の量および改質反応に伴う理論吸熱量と理論発熱量とに基づいて決定されるので、改質反応に伴う吸熱量と発熱量とをバランスさせて改質反応が生じる部分の温度を所定の温度に維持することができ、その結果、改質反応を良好に進行させて高品質の燃料を得ることできる。

【００４１】また請求項２の発明によれば、改質燃料の量に変動がある場合、その量の変動に伴う改質反応の変動の時間的遅れに応じて供給酸素量を補正するので、改質反応の生じる部分の温度が更に正確に維持され、形態を変更した高品質の燃料を得ることができる。

【００４２】請求項３の発明によれば、改質反応の生じる部分の温度に基づいて、酸化反応に供される酸素供給量を補正するので、改質反応の生じる部分の温度が更に正確に制御され、その結果、改質反応が安定して、形態を変更した高品質の燃料を得ることができる。

【００４３】そして請求項４の発明によれば、酸素量決定手段で決定された量の酸素を供給するための指令信号を出力するにあたり、酸素の供給圧などの状態量を推定し、その推定値に基づいて酸素供給指令値を設定するので、酸素の供給量が正確になり、その結果、改質反応が安定して、形態を変更した高品質の燃料を得ることができる。

【図面の簡単な説明】

【図１】　この発明による制御装置で実行される制御例を説明するためのフローチャートである。

【図２】　改質器を燃料電池に接続したシステムの全体的な構成を模式的に示す図である。

【図３】　その改質部を模式的に示す図である。

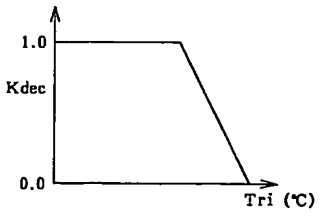
【図４】　温度による部分坂エアー供給量の補正をおこなうための係数を決定するマップの例を示す図である。

【図５】　圧力をパラメータとした部分酸化エアー供給量とエアーポンプ指令値との関係を示すマップの一例を示す図である。

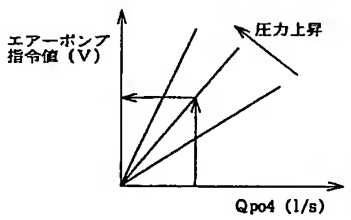
【符号の説明】

１…　燃料電池、　２…改質器、　３…加熱部、　４…改質部、　６…燃焼部、　７…蒸発部、　１３…エアーポンプ、　２４…電子制御装置、　４１…触媒層、　４４…部分酸化エアー供給管、　４６，４７…温度センサ、　４８…圧力センサ。

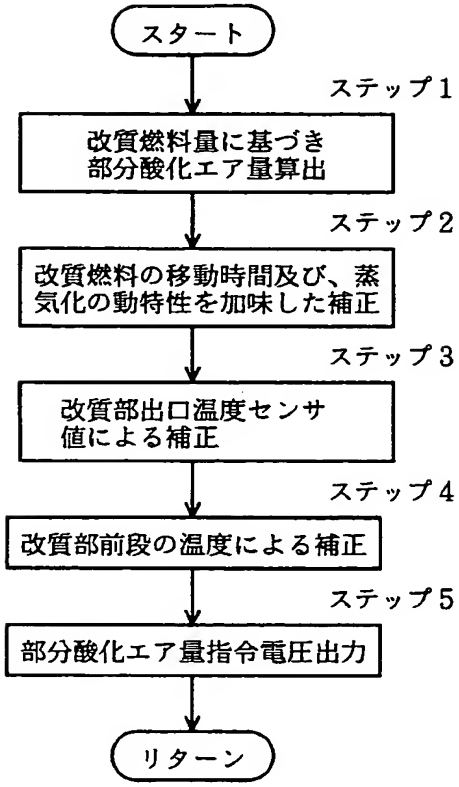
【図４】



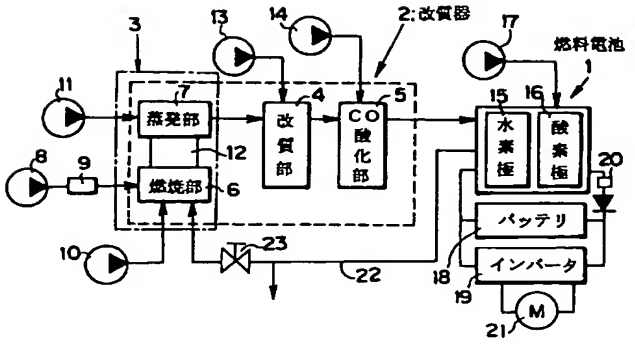
【図５】



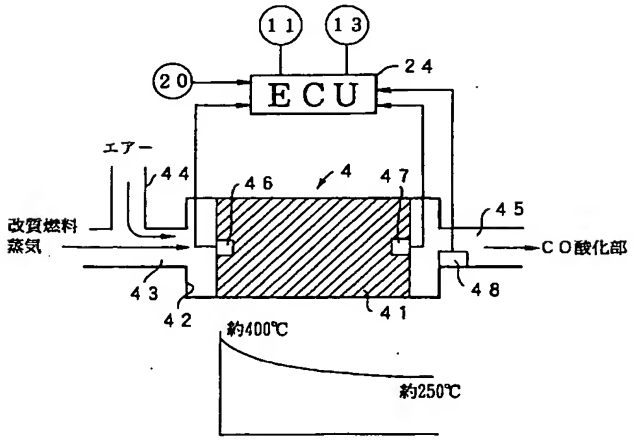
【図１】



【図２】



【図３】



フロントページの続き

(72)発明者　山岡　正明
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内

(72)発明者　本園　貴一
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内

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